Pesticides Registered in Virginia Commonly Used to Control Mosquitoes

Larvicides: Insecticides applied to bodies of water identified as mosquito breeding areas to kill mosquitoes during the larval or pupal stages.

- ***Bacillus thuringiensis israelensis (Bti)***. Spores of this naturally occurring soil bacterium contain a pure toxin which disrupts the gut of mosquitoes and primitive fly species by binding to receptor cells present. It has little effect in other insect species. Bti will not affect mosquito larvae that have developed past the late 4th instar, or are in the pupal stage of development. Bti is not toxic to birds, mammals or fish and is practically non toxic to amphibians.

  Bacillus thuringiensis israelensis (Vectobac formulation*) has an oral LD_{50}* (rats) of >5000 mg/kg, and a dermal LD_{50}* (rabbits) of >2500 mg/kg.

- ***Bacillus sphaericus***. A naturally occurring bacterium also contains a toxin that disrupts the gut of mosquito larvae by binding to receptor cells found in certain species of mosquitoes. *B. sphaericus* will not affect mosquito larvae that have developed past the late 4th instar, or are in the pupal stage of development. *B. sphaericus* is not toxic to mammals or other animal groups. Data on toxicity to other arthropods is unavailable.
- ***B. sphaericus*** is very effective against *Culex* mosquito species found in water with high organic content.

  Bacillus sphaericus (Vectolex formulation*) has an oral LD_{50}* (rats) of >5000 mg/kg, and a dermal LD_{50}* (rabbits) of >2000 mg/kg.

- **Methoprene**. (Altosid). An insect growth regulator that prevents the normal maturation of insect larvae. Methoprene will not affect mosquito larvae that are developed past the late 4th instar, or are in the pupal stage of development. Methoprene has little effect on mammals, snails, frogs, mosquito fish, or on aquatic insects from orders with incomplete metamorphosis (e.g., will not affect mayflies, stoneflies, dragonflies, or damselflies, but may affect aquatic beetles and true flies). Methoprene may be slightly toxic to birds and slightly to moderately toxic to some species of fish. It may be highly toxic to aquatic to freshwater and estuarine invertebrates such as crabs or shrimp.

  Methoprene (technical grade) has an oral LD_{50}* (rats) of >5000 mg/kg, and a dermal LD_{50}* (rabbits) of >2000 mg/kg.

- **Temephos**. (Abate). An organophosphate insecticide that has a low to moderate mammalian toxicity. Temephos is highly effective against all mosquito larval stages but will not easily kill mosquito pupae. Temephos

can be highly toxic to some bird species and to some aquatic organisms such as certain fish species, freshwater insects, and other invertebrates (e.g., shrimp, crabs, mollusks).

Temephos (technical grade) has a variable oral LD_{50}* in rats that could be as low as 1226 mg/kg, and a dermal LD_{50}* (rabbits) of 1155 mg/kg.

- **Monomolecular Films (**Agnique**)**. Chemicals which spread a thin film on the surface of the water and make it difficult for mosquito larvae, pupae or emerging adults to break through or attach to the water's surface, causing them to drown. Typically films remain active for 10-14 days on standing water.

- **Surface Oils**. Similar to monomolecular films, oils form a coating on top of water to drown larvae, pupae and emerging adult mosquitoes. Oils do not pose a risk to human health. However, they may be toxic to amphibians, fish and other aquatic organisms if misapplied.

Adulticides: Insecticides, typically applied with ultra low volume (ULV) spray equipment, that dispenses the pesticide as a fine fog to kill adult mosquitoes. ULV releases a few ounces per acre of treated area, and is released as tiny particles (generally <50 micron sized droplets) of insecticide solution that drift in the air. Insecticides can only be used for fogging applications if they are labeled for that purpose. Adulticides may also be applied as a liquid surface spray or applied as a ULV mist (larger droplet sizes of >50 microns) to leave a toxic residual "barrier treatment" on surfaces (walls, ceilings, eaves and shrub or ivy foliage) where mosquitoes land and rest. Insecticides can only be used for barrier treatments if they are labeled for that purpose.

Organophosphate Insecticides – Because organophosphates are neurotoxins that readily affect mammalian nervous systems (cholinesterase inhibitors), exposure to high doses can over-stimulate the nervous system and cause convulsions, respiratory paralysis and death. Most organophosphates are toxic to fish and aquatic invertebrates and are highly toxic to honeybees.

- **Malathion**. An organophosphate insecticide applied by truck-mounted or aircraft-mounted ULV sprayers at a maximum rate of 0.23 pounds (2.5 fluid ounces) of active ingredient per acre. Malathion has a relatively low toxicity to humans and other mammals, is moderately toxic to birds and has a wide range of toxicities to different fish species. It is highly toxic to amphibians and aquatic invertebrates, and should not be applied over water with ground fogging equipment. Malathion is highly toxic to honeybees and should not be applied at times and locations where bees are foraging.

  Malathion (e.g., Fyfanon ULV formulation) has an oral LD_{50}* (rats) of 2830 mg/kg; a dermal LD_{50}* (rats) of 2000 mg/kg; and an inhalation

LC_{50}** (rats) of >5000 mg/m^3 (4 hour exposure).

- **Naled** (dibrom) can be applied by truck-mounted or aircraft-mounted ULV sprayers at a maximum rate of 0.05 pounds (0.8 ounces) of active ingredient per acre by air and 0.33 ounce per acre by ground equipment. Naled is moderately toxic to humans and other mammals, and moderately to highly toxic to birds. It may also be moderately to highly toxic to fish and highly toxic to aquatic invertebrates and should not be applied over water with ground fogging equipment. Naled is highly toxic to honeybees and should not be applied at times and locations where bees are foraging. Naled is also highly corrosive and will damage the paint on cars or other objects that are too close to the sprayer.

  Naled (e.g., Trumpet EC formulation*) has an oral LD_{50}* (rats; female) of 180 mg/kg; a dermal LD_{50}* (rats; female) of 360 mg/kg, and an inhalation LC_{50}** (rats) of 1520 mg/m^3 (6 hour exposure).

Pyrethroid Insecticides - Due to their toxicity to fish, many of these products have restrictions which prohibit the direct application of these products to open water or within 100 feet of lakes streams, rivers or bays. Pyrethroids are also highly toxic to honeybees and care must be taken not to spray in areas and at times when honeybees are foraging.

- **Permethrin** can be applied by backpack, truck, or aircraft mounted foggers at a maximum rate of 0.0036 pounds (0.057 ounces) of active ingredient per acre. Some permethrin formulations are labeled for use as barrier treatments. Permethrin is practically non-toxic to birds and has a low mammalian toxicity. Permethrin is highly toxic to fish and aquatic invertebrates (crabs, mollusks) and should not be applied where surface water is present or where air movement favors drift towards aquatic environments. Permethrin is extremely toxic to honeybees and should not be applied at times and locations where bees are foraging.

  Permethrin (e.g., Aqua-Resilin formulation*) has an oral LD_{50}* (rats) of 1000 mg/kg; a dermal LD_{50}* (rabbits) of >5000 mg/kg, and an inhalation LC_{50}** (rats) of 2870 mg/m^3 (4 hour exposure).

- **Resmethrin** can be applied by backpack, truck, or aircraft mounted foggers at a maximum rate of 0.0035 pounds (0.056 ounces) of active ingredient per acre. Resmethrin is practically non-toxic to birds and has a low mammalian toxicity. Resmethrin is very is highly toxic to fish and aquatic invertebrates and should not be applied where surface water is present or where air movement favors drift towards aquatic environments. Resmethrin is highly toxic to honeybees and should not be applied at times and locations where bees are foraging.

Resmethrin (e.g., Scourge formulation*) has an oral LD_{50}* (rats) of 2700 mg/kg; a dermal LD_{50}* (rabbits) of >2000 mg/kg, and an inhalation LC_{50}** (rats) of 2640 mg/m^3 (4 hour exposure).

. **Sumethrin** can be applied by backpack, truck, or aircraft mounted foggers at a maximum rate of 0.0036 pounds (0.057 ounces) of active ingredient per acre. Sumithrin has a moderate toxicity to aquatic invertebrates and is very highly toxic to fish and should not be applied where surface water is present or where air movement favors drift towards aquatic environments. Data on toxicity to birds and bees was unavailable.

Sumethrin (Anvil formulation*) has an oral LD_{50}* (rats) of >5000 mg/kg; a dermal LD_{50}* (rabbits) of >2000 mg/kg, and an inhalation LC_{50}** (rats) of 4570 mg/m^3 (4 hour exposure).

* LD_{50} = The lethal dosage of pesticide that would kill 50% of test animals (usually rats), expressed as milligrams of pesticide per kilogram of the animals body weight. The lower the value for an LD_{50}, the more toxic the pesticide will be. The LD_{50} for oral or dermal toxicity can vary from one insecticide formulation to another (e.g., two different formulations of the same insecticide could vary significantly, and pure technical grade material might be less toxic than some formulations of lower concentration). Although the effects of an insecticide would not be the same for humans as for rats, test rats are used as a rough equivalent for the pesticide's effects on mammals or humans. Translated to humans, an oral LD_{50} of 5000 mg/kg (5 grams/kg) would mean that a human weighing roughly 100 kg (220 lbs) would have to consume 500 grams (1 pound) of pesticide to suffer a 50% mortality rate. An oral LD_{50} of >5000 mg/kg is generally not considered to be very toxic. Table salt is not generally considered to be toxic, however, a 100 kg human who consumed 500 grams of table salt would suffer considerable or possibly lethal toxic effects.

** LC_{50} = The lethal concentration of pesticide that would kill 50% of test animals (usually rats) after a specified amount of time breathing this concentration. The LC_{50} for inhalation is usually expressed as milligrams of pesticide per cubic meter of air.